

CLAIMS

1. A catheter system to change the temperature of blood by heat transfer to or from a circulating
5 working fluid, comprising:
 a supply lumen to introduce a circulating working fluid to a heat transfer element; and
 and
 a return lumen to extract a circulating working fluid from the heat transfer element, the return
lumen having a cross-sectional area greater than the cross-sectional area of the supply lumen to
10 enhance flexibility of the heat transfer element.
2. The system of claim 1, wherein the heat transfer element is made of a flexible conductive metal.
3. The system of claim 1, wherein the heat transfer element is a balloon having a substantially straight
15 inlet lumen and a helical outlet lumen, the helical outlet lumen helically encircling the substantially
straight inlet lumen.
4. The system of claim 3, wherein multiple helical outlet lumens are provided.
- 20 5. The system of claim 4, wherein three helical outlet lumens are provided.
6. The system of claim 3, wherein the inlet lumen and the outlet lumen are made of a flexible material.
7. The system of claim 6, wherein the flexible material is rubber.
- 25 8. The system of claim 6, wherein the flexible material is a material capable of undergoing inflation.
9. The system of claim 1, wherein the working fluid is saline.
- 30 10. The system of claim 3, wherein a length of the inlet lumen is between about 5 and 30 centimeters.

11. The system of claim 3, wherein a diameter of the helical shape of the outlet lumen is less than about 8 millimeters when inflated.

12. The system of claim 1, further comprising a working fluid supply including a pump, and wherein
5 the pump circulates the working fluid.

13. The system of claim 12, wherein the working fluid supply is configured to produce a pressurized working fluid at a temperature of between about -3°C and 36°C and at a pressure below about 5 atmospheres of pressure.

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14. The system of claim 3, wherein the outlet lumen includes a surface coating or treatment to inhibit clot formation.

15. The system of claim 14, wherein the surface coating or treatment includes heparin.

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16. A method of providing flexibility in a catheter for use in a system to change the temperature of blood by heat transfer to or from a circulating working fluid, comprising:

providing a catheter including:

a supply lumen to introduce a circulating working fluid to a heat transfer element; and

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and

a return lumen to extract a circulating working fluid from the heat transfer element, the return lumen having a cross-sectional area greater than the cross-sectional area of the supply lumen to enhance flexibility of the heat transfer element; and

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circulating fluid through the supply lumen and return lumen to change the temperature of the heat transfer element to a temperature different from a patient temperature, to heat or cool the patient.

17. The system of claim 16, wherein the heat transfer element is made of a flexible conductive metal.

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18. The system of claim 16, wherein the heat transfer element is a balloon having a substantially straight inlet lumen and a helical outlet lumen, the helical outlet lumen helically encircling the substantially straight inlet lumen.

19. The system of claim 18, wherein multiple helical outlet lumens are provided.

20. The system of claim 19, wherein three helical outlet lumens are provided.

21. The system of claim 18, wherein the inlet lumen and the outlet lumen are made of a flexible material.

22. The system of claim 21, wherein the flexible material is rubber.

23. The system of claim 21, wherein the flexible material is a material capable of undergoing inflation.

24. The system of claim 16, wherein the working fluid is saline.

25. The system of claim 18, wherein a length of the inlet lumen is between about 5 and 30 centimeters.

26. The system of claim 18, wherein a diameter of the helical shape of the outlet lumen is less than about 8 millimeters when inflated.

27. The system of claim 16, further comprising a working fluid supply including a pump, and wherein the pump circulates the working fluid.

28. The system of claim 27, wherein the working fluid supply is configured to produce a pressurized working fluid at a temperature of between about -3°C and 36°C and at a pressure below about 5 atmospheres of pressure.

29. The system of claim 18, wherein the outlet lumen includes a surface coating or treatment to inhibit clot formation.

30. The system of claim 29, wherein the surface coating or treatment includes heparin.

31. A method of determining pressure in a catheter for use in a system to change the temperature of blood by heat transfer to or from a circulating working fluid, comprising:

providing a catheter including:

a supply lumen to introduce a circulating working fluid to a heat transfer element; and
and

a return lumen to extract a circulating working fluid from the heat transfer element;

5 circulating fluid via a pump through the supply lumen and return lumen to change the
temperature of the heat transfer element to a temperature different from a patient temperature, to heat
or cool the patient;

monitoring the pump speed and current drawn by the pump and using the same in a calculation
of pressure.

10 32. The method of claim 31, further comprising measuring the efficiency of the pump and
using the same in a calculation of pressure.

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